



UNIVERSITI PUTRA MALAYSIA

**UTILIZATION OF LEGUME FORAGES AS PROTEIN
SUPPLEMENTS FOR RUMINANTS**

BODEE KHAMSEEKHEW

FP 2001 11

**UTILIZATION OF LEGUME FORAGES AS PROTEIN
SUPPLEMENTS FOR RUMINANTS**

By

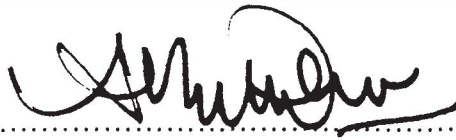
BODEE KHAMSEEKHIEW

**Thesis Submitted in Fulfilment of the Requirement for the Degree of
Master of Science in the Faculty of Agriculture
Universiti Putra Malaysia**

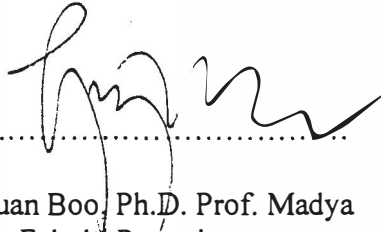
April 2001



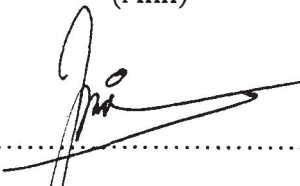
Adalah disahkan bahawa kami telah membaca tesis ini yang bertajuk "Utilisation of Legume forages as Protein Supplements for Ruminants" Oleh Bodee Khamseekhiew dan berpendapat bahawa tesis ini adalah memuaskan daripada segi skop, kualiti dan persembahan sebagai memenuhi syarat keperluan untuk ijazah Master Sains.



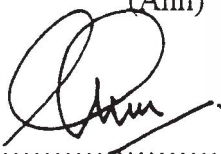
Abdul Razak Alimon, Ph.D. Prof. Madya
Fakulti Pertanian
Universiti Putra Malaysia
(Pengerusi/Wakil Dekan Pengajian Siswazah)



Liang Juan Boo, Ph.D. Prof. Madya
Fakulti Pertanian
Universiti Putra Malaysia
(Ahli)



Zainal Aznam bin Mohd. Jelani, Ph.D. Prof. Madya
Fakulti Pertanian
Universiti Putra Malaysia
(Ahli)



Wong Choi Chee, Ph.D.
Malaysian Agricultural Research and Development Institute (MARDI),
(Ahli)

Nota: Para pemeriksa dikehendaki meneliti / menyemak tesis pelajar terlebih dahulu sebelum menandatangani borang ini.

I wish to dedicate this thesis to my beloved parents, Poh Chile and Mae Paa Khamseekiew, who always understand and give me loving support.

Abstract of the thesis presented to the senate of Universiti Putra Malaysia in
fulfilment of the requirement for the Degree of Master of Science

UTILIZATION OF LEGUME FORAGES AS PROTEIN SUPPLEMENTS FOR RUMINANTS

By

BODEE KHAMSEEKHIEW

April 2001

Chairman : Associate Professor Liang Juan Boo, Ph.D.

Faculty : Agriculture

An assessment of four legume forages, namely *Leucaena hybrid-Bahru* (*Leucaena-Bahru*), *Leucaena hybrid-Rendang* (*Leucaena-Rendang*), *Gliricidia sepium* (*G. sepium*) and *Arachis pintoi* (*A. pintoi*) as protein supplements for ruminants was conducted in four studies. In experiment 1, chemical composition and ruminal and intestinal digestibilities of the test materials were determined. Crude protein (CP) contents of the two *Leucaena* hybrids and *G. sepium* were over 20%, while that for *A. pintoi* was marginally lower. Tannin content of *Leucaena* hybrids (averaged of 7.9%) was significantly ($p<0.05$) higher than those of *G. sepium* (3.7%) and *A. pintoi* (2.0%). Ruminal and intestinal digestibilities of *G. sepium* and *A. pintoi* were significantly ($p<0.05$) higher than those of *Leucaena* hybrids, while digestibility differences between *G. sepium* and *A. pintoi* were smaller. Total tract digestibility for *G. sepium* was the highest (85.6%), followed closely by *A. pintoi*

(78.4%). The above values were significantly higher ($p < 0.05$) than those of the two *Leucaena* hybrids (averaged 52.2%).

In experiment 2, the effects of levels of legume supplementation on fibre digestion and rumen environment were examined. The results showed that increasing legume supplementations improved ruminal NH_3N and VFA concentrations and DM digestion. The results of this experiment indicate 40% supplementation would provide on optimal level of NH_3N for microbial synthesis.

In experiment 3, acceptability (palatability) of the three legumes was examined using the choice feeding technique in sheep. The sheep showed highest preference for *Leucaena-Bahru*, followed by *A. pinto* and *G. sepium*, but intake of *A. pinto* the highest, followed by *Leucaena-Bahru* and *G. sepium*.

In the final experiment, the effects of increasing levels of legume supplementation on intake, N balance and performance in sheep were examined. Fibre (using OPF as test material) and total DM intakes and average daily gain (ADG) increased with increasing levels of *Leucaena-Bahru* and *A. pinto* supplementation. *Leucaena* supplemented animals excreted higher urinary N as compared to their counterparts supplemented with *A. pinto*. This had resulted in lower N retentions for *Leucaena* treated animals which were reflected by the lower ADG. The study on microbial N (MN) productions using purine derivative (PD) excretion technique showed that MN production was positively correlated with

increased level of legume supplementation, but the response was not significant between legume types.

The four legumes could be useful protein supplements to improve the efficiency of utilisation of fibrous agricultural byproducts such as OPF in ruminant diets. However, the low digestibility of the two psyllid resistant *Leucaena* hybrids, together with their low N retention and body weight gain when fed to animal have cast doubt over the actual usefulness of the above *Leucaena* hybrids. Tannin was postulated to be the primary factor affecting the low digestibility and the efficiency of utilisation of the *Leucaena* hybrids. However, the above postulation requires further investigations.

Abstrak tesis yang dikemukkakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat keperluan untuk Ijazah Master Sains

**PENGUNAAN FORAJ LEGUM SEBAGAI SUPLEMEN PROTEIN
UNTUK RUMINAN**

Oleh

BODEE KHAMSEKHIEW

April 2001

Pengerusi : Profesor Madya Liang Juan Boo, Ph.D.

Fakulti : Pertanian

Satu penilaian telah dilakukan ke atas empat jenis foraj legum, iaitu hibrid *Leucaena-Bahru* (*Leucaena-Bahru*), hibrid *Leucaena-Rendang* (*Leucaena-Rendang*), *Gliricidia sepium* (*G. sepium*) dan *Arachis pintoi* (*A. pintoi*) sebagai bahan penambah protein untuk ruminan. Dalam kajian pertama, kandungan kimia serta nilai cerna daripada rumen dan usus kecil bagi foraj legum tersebut telah ditentukan. Kandungan protein kasar (CP) daripada kedua-dua hibrid *Leucaena* dan *G. sepium* masing-masingnya melebihi 20%, manakala bagi *A. pintoi* kandungannya lebih rendah. Kandungan tannin bagi kedua-dua hibrid *Leucaena* dengan purata sebanyak 7.9% didapati lebih tinggi ($p<0.05$) daripada *G. sepium* (3.7%) dan *A. pintoi* (2.0%). Nilai cerna rumen dan usus kecil bagi *G. sepium* dan *A. pintoi* adalah lebih tinggi ($p<0.05$) daripada kedua-dua hibrid *Leucaena*. Walau bagaimanapun, perbezaan nilai cerna *G. sepium* didapati paling tinggi (85.6%), diikuti oleh *A. pintoi* (78.4%).

Nilai-nilai ini ternyata lebih tinggi ($p < 0.05$) daripada kedua-dua hibrid *Leucaena* dengan purata 52.5%.

Kajian kedua menentukan kesan aras penambahan legum terhadap pencernaan serabut dan persekitaran rumen. Hasil yang diperolehi menunjukkan peningkatan penambahan legum telah meninggikan kandungan nitriden-ammonia (NH_3N) dan kepekatan asid lemak meruap (VFA) rumen serta nilai cerna bahan kering. Hasil kajian ini juga menunjukkan penambahan pada aras 40% memberikan kandungan NH_3N paling optimum bagi sintesis mikrob.

Dalam kajian ketiga, penerimaan (palatabiliti) tiga jenis legum telah diuji pada biri-biri melalui kaedah pemakanan pilihan. Biri-biri didapati lebih menggemari *Leucaena-Bahru*, diikuti *A. pintoi* dan *G. sepium*. Walau bagaimanapun, ia memakan lebih banyak *A. pintoi*, diikuti *Leucaena-Bahru* dan *G. sepium*.

Dalam kajian terakhir, kesan penambahan aras legum terhadap pengambilan makanan,imbangan N dan prestasi biri-biri telah diselidiki. Kandungan serabut (OPF), jumlah pengambilan bahan kering dan pertambahan berat badan (ADG) didapati meningkat dengan peningkatan aras *Leucaena-Bahru* dan *A. pintoi*. Ternakan yang diberi penambahan *Leucaena* menghasilkan lebih banyak N urin dibandingkan dengan ternakan yang diberi makan *A. pintoi*. Ini menyebabkan retensi N pada ternakan yang diberi makan *Leucaena* menjadi rendah sehingga menurunkan ADG. Kajian terhadap pengeluaran N mikrob (MN) menggunakan teknik pembebasan derivatif purin (PD) menunjukkan pengeluaran MN adalah berkat

rapat dengan peningkatan aras legum. Walaupun begitu, rangsangan ini tidak nyata dari segi statistik di antara jenis legum.

Secara kesimpulannya, berasaskan kandungan kimia, keempat-empat legum yang dikaji merupakan penambah protein yang baik bagi ruminan bagi meningkatkan kecekapan penggunaan bahan-bahan sampingan pertanian berserabut seperti OPF. Walau bagaimanapun, kerendahan nilai cerna kedua-dua jenis hibrid *Leucaena* yang “rentan psyllid” ini, disokong pula dengan kerendahan retensi N dan penurunan berat badan memaksa pengolahan semula dari segi faedah legum berkenaan dalam pemakanan ternakan. Tannin diramalkan menjadi fakfor utama yang merendahkan nilai cerna dan merencatkan lecekapan penggunaan hibrid *Leucaena*. Walau bagaimanapun, andaian ini memerlukan kajian lanjutan.

ACKNOWLEDGEMENTS

I wish to express my appreciation and sincere gratitude to my supervisor, Associate Professor Dr. Liang Juan Boo for his invaluable guidance, constructive criticisms, and continuous encouragement. My deep appreciation also go to the members of my supervisory committee, Associate Professor Dr. Zainal Aznam bin Mohd.

Development Institute (MARDI), for their continuous interest, helpful suggestion and advice throughout this research project and in the preparation of this thesis.

I am indebted to Associate Professor Dr. permission to use his metabolism cases during my research. Thanks are also due to Dr. analyses.

My appreciation to Professor Dr. Thailand and Dr. their useful suggestions and encouragement at the beginning of my study. I acknowledge the useful discussion with Professor Dr. on several points in this thesis and Dr. preparing the abstract in Bahasa Malayu.

Special thanks go to the staff of MARDI for their assistance in collecting the fodder materials.

Rahman and Saparin bin Demin of the Nutrition Laboratory, is gratefully acknowledged. My personal thanks are extended to my fellow graduate students and all Thai students in UPM particularly, Mr. Opart Pimpa, Dr. Suthipong Pruangka, Dr. Mongkon Ta_oun, Ms Cheunsikah Chemong and Ms Benchamaporn Wongsuban for their friendly guidance.

Finally, my deepest gratitude to my parents, Poh Chile and Mae Paa Khamseekhiew for their understanding and moral support during the study.

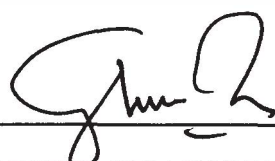
I certify that an Examination Committee met on 13th April 2001 to conduct the final examination of Bodee Khamseekhiew on his Master of Science thesis entitled "Utilisation of Legume Forages as Protein Supplements for Ruminants" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Abdul Razak Alimon, Ph.D. Prof. Madya
Department of animal Science,
Faculty of Agriculture,
Universiti Putra Malaysia
(Chairman)

Liang Juan Boo, Ph.D. Prof. Madya
Department of Animal Science,
Faculty of Agriculture,
Universiti Putra Malaysia
(Member)

Zainal Aznam bin Mohd. Jelani, Ph.D. Prof. Madya
Department of Animal Science,
Faculty of Agriculture,
Universiti Putra Malaysia
(Member)

Wong Choi Chee, Ph.D.
Malaysian Agricultural Research and Development Institute (MARDI)
(Member)



MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor
Deputy Dean of Graduate School
Universiti Putra Malaysia

Date: 30 APR 2001

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science.



MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor
Deputy Dean of Graduate School
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

Bodee Khamseekhiew.

(BODEE KHAMSEEKHIEW)

Date: 24/04/2001.

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGEMENTS	ix
APPROVAL SHEETS	xi
DECLARATIONS	xiii
LIST OF TABLES	xvii
LIST OF FIGURES	xix
LIST OF PLATES	xx
LIST OF ABBREVIATIONS	Xxi

CHAPTER

1	INTRODUCTION	1
2	LITERATURE REVIEW	4
	2.1 Fodder Legumes as Ruminant Feed	4
	2.2 Common Legume Species as Ruminant Feed	4
	2.3 Dry Matter Yield	6
	2.4 Forage Quality	8
	2.4.1 Chemical Composition	8
	2.4.2 Acceptability and Feed Intake	10
	2.4.3 Anti-Nutritive Factors	12
	2.4.4 Mimosine	12
	2.4.5 Tannin	14
	2.4.6 Other Anti-Nutritive Factors	15
	2.4.7 Digestibility	15
	2.4.8 Protein Supplementation	18
	2.4.9 Microbial protein	19
	2.4.10 Bypass Protein	20
	2.5 Animal Production	21
	2.5.1 Live Weight Gain	21
	2.6 Conclusion and Scope of Studies	22
3	NUTRITIVE VALUE, DIGESTIBILITY AND BYPASS PROTEIN IN LEGUME FORAGES	25
	3.1 Introduction	25
	3.2 Materials and Methods	26
	3.2.1 Sample Preparation	26
	3.2.2 Animals and Feeding	27



	3.2.3	Ruminal Digestibility	27
	3.2.4	Intestinal Digestibility	28
	3.2.5	Chemical Analyses	28
	3.2.6	Data and Statistical Analysis	29
3.3	Results		29
	3.3.1	Chemical Composition of Legume Forages	29
	3.3.2	Ruminal Digestibility	31
	3.3.3	Intestinal Digestibility	34
3.4	Discussion		37
4	EFFECTS OF VARIOUS LEVELS OF <i>Arachis pinto</i> SUPPLEMENTATION ON OPF DEGRADATION		41
	4.1	Introduction	41
	4.2	Materials and Methods	42
	4.2.1	Sample Preparation	42
	4.2.2	Animals and Feeding	43
	4.2.3	Ruminal Digestibility	43
	4.2.4	Ruminal Fluid Collection	44
	4.2.5	Chemical analysis	44
	4.2.6	Data and Statistical Analysis	44
	4.3	Results	45
	4.3.1	DM Digestion	45
	4.3.2	NDF Digestion	45
	4.3.3	Rumen pH	49
	4.3.4	Rumen NH ₃ N	49
	4.3.5	Rumen VFA	51
	4.4	Discussion	51
5	PALATABILITY OF LOCAL LEGUME FORAGES IN SHEEP		55
	5.1	Introduction	55
	5.2	Materials and Methods	56
	5.2.1	Sample Preparation	56
	5.2.2	Animals and Feeding	56
	5.3	Results	58
	5.3.1	Frequency	58
		Consumption of Forage	58
	5.4	Discussion	59
6	FEEDING OF LEGUMES SUPPLEMENTATION ON INTAKE, NITROGEN BALANCE AND PERFORMANCE IN SHEEP		62
	6.1	Introduction	62
	6.2	Materials and Methods	63

6.2.1	Sample Preparation	63
6.2.2	Animal and Feeding	63
6.2.3	Experimental Period	63
6.2.4	Feed Intake and Body Weight Change	65
6.2.5	Digestibility Trial	65
6.2.6	Chemical Analyses	66
6.2.7	Data and Statistical Analysis	67
6.3	Results	67
6.3.1	Feed Intake	67
6.3.2	Nitrogen Utilisation and Average Daily Change	69
6.3.3	Purine Derivative Excretion and Microbial Nitrogen Production	71
6.4	Discussion	
7	GENERAL DISCUSSION AND CONCLUSION ..	
REFERENCES	
APPENDIES		
A	Determination of Volatile Fatty acids (VFA)	
B	Calculation of Urinary Purine Derivative Excretion	
C	Additional Table	
D	Programm for Evaluation DM Degradation	
E	Additional Plates	
VITA	

LIST OF TABLES

Table	Page
2.1 Some Tropical Fodder Tree and Shrub Used as Ruminants Feed	5
2.2 Leaf Dry Matter (DM) Yields (t/ha/yr) of Some Fodder Legumes in the Tropics	7
2.3 Crude Protein (CP), Ether-Extract (EE), Crude Fiber (CF), Neutral Detergent Fibre (NDF), Ash, Phosphorous (P), Calcium (Ca), Tannin (Tan), Lignin (Lig) and Dry Matter Digestibility (DMD) Based on DM Basis of Some Fodder Legumes in the Tropics	9
2.4 List of Some of Anti-Nutritive and Toxic Factors (ANF) Found in Fodder Tree Legumes and Shrubs Species	13
2.5 <i>In vitro</i> , <i>in sacco</i> , and <i>in vivo</i> Digestibility and Voluntary Feed Intake (VFI) of Some Legume Species in Various Ruminants	17
2.6 Dry Matter and Protein Digestibility for <i>Leucaena Leucocephala</i> Forage	18
2.7 The Effect of Increasing Levels of Forage Tree Legume Supplements on Productivity of Cattle, Sheep and Goats	22
3.1 Chemical composition of <i>Leucaena-Bahru</i> , <i>Leucaena-Rendang</i> <i>Gliricidia sepium</i> and <i>Arachis pintoii</i> (% DM basis)	30
3.2 Percentage of DM and CP degradabilities of <i>Leucaena- Bahru</i> , <i>Leucaena-Rendang</i> , <i>Gliricidia sepium</i> , and <i>Arachis pintoii</i> , incubated in rumen of Kadah-Kelantan cattle fed 60% OPF and 40% mixed legumes diet	32
3.3 Ruminal (24 h. incubation) and intestinal DM and CP degradations (%) of <i>Leucaena-Bahru</i> , <i>Leucaena-Rendang</i> , <i>Gliricidia sepium</i> , and <i>Arachis pintoii</i>	35
4.1 Experimental design showing the various feeding treatments in the 4 experimental periods	43
4.2 Dry matter (DM) degradability of OPF as affected by different levels	

	of legume supplementation in OPF based diet	46
4.3	NDF degradability of OPF as affected by different levels of legume supplementation in an OPF based diet	47
4.4	The Mean Values of Ruminant pH, Molar Proportion (%) of Volatile Fatty Acids (VFAs) and Total VFA in Cattle Fed Four Combinations of OPF and legume in KK Cattle	50
5.1	Palatability (frequency of preference) for <i>Leucaena-Bahru</i> , <i>Gliricidia sepium</i> , <i>Arachis pintoii</i> and Guinea grass offered to sheep	58
5.2	Average accumulative consumption of <i>Leucaena-Bahru</i> , <i>Gliricidia sepium</i> , and <i>Arachis pintoii</i> and Guinea grass by sheep during the different feeding duration	59
6.1	Diet Treatments indicating the amount of legume supplement in an oil palm frond (OPF)* based diet	64
6.2	Effect of <i>Leucaena-Bahru</i> and <i>Arachis pintoii</i> supplementation on OPF and total DM intake in lambs	68
6.3	Effects of <i>Leucaena – Bahru</i> and <i>Arachis pintoii</i> Supplementation on Nitrogen (N) Utilisation in Lambs fed OPF Based Diet	70
6.4	Effects of supplemented various levels of <i>Leucaena-Bahru</i> and <i>Arachis pintoii</i> on urinary purine derivative (PD) excretion and microbial nitrogen (MN) production on OPF based diet in lambs	72

LIST OF FIGURES

Figure		Page
3.1	Dry matter (DM) degradation curves of <i>Gliricidia sepium</i> (X), <i>Arachis pintoi</i> (◇), <i>Leucaena-Rendang</i> (Δ) and <i>Leucaena-Bahru</i> (□) incubated in the rumen of KK cattle	33
3.2	Crude protein (CP) degradation curves of <i>Gliricidia sepium</i> (X), <i>Arachis pintoi</i> (◇), <i>Leucaena-Rendang</i> (Δ) and <i>Leucaena-Bahru</i> (□) incubated in the rumen of KK cattle	33
3.3	Dry matter (DM) degradation in the rumen and intestine of <i>Leucaena-Bahru</i> (LB), <i>Leucaena-Rendang</i> (LR), <i>Gliricidia sepium</i> (GS) and <i>Arachis pintoi</i> (AP)	36
3.4	Crude protein (CP) degradation in the rumen and intestine of <i>Leucaena-Bahru</i> (LB), <i>Leucaena-Rendang</i> (LR), <i>Gliricidia sepium</i> (GS) and <i>Arachis pintoi</i> (AP)	36
4.1	Changes of ruminal pH after morning feeding as affected by different level of legume supplementation in an OPF based diet in KK cattle	48

LIST OF PLATES

Plate	Page
1 <i>Leucaena leucocephala</i>	
2 <i>Gliricidia sepium</i>	
3 <i>Arachis pintoi</i>	
4 Mobile bags for intestinal digestion trial	
5 Duodenal cannula	
6 Ruminant cannula of Kedah Kelantan cattle	

LIST OF ABBREVIATIONS

ADG	- Average Daily Gain
ADF	- Acid Detergent Fibre
ADL	- Acid Detergent Lignin
ANF	- Anti-Nutritive factors
ANOVA	- Analysis of Variance
AOAC	- Association Official Agricultural Chemists
ARC	- Agricultural Research Council
DDMI	- Digestible Dry Matter Intake
DMD	- Dry Matter Digestibility
DHP	- 3-Hydroxy-4 (1H)-pyridone
EE	- Ether Extract
HT	- Hydrolysable Tannin
LWG	- Live Weight Gain
NAS	- National Academy of Sciences
NDF	- Neutral Detergent Fibre
NRC	- National Research Council
OPF	- Oil Palm Fronds
SAS	- Statistical Analysis System
VFA	- Volatile Fatty Acids

CHAPTER I

GENERAL INTRODUCTION

Ruminant livestock production in Southeast Asia farming systems is highly dependent on the utilisation of natural forages and crop residues. The natural forages are generally low in yield and of poor quality particularly during the dry seasons. Similarly, the crop residues are low in digestibility and are inadequate to sustain high animal productivity. One of the strategies to improve animal productivity and efficiency under the above situation is to increase efficiency of utilisation of the low quality forages and crop residues through appropriate feed supplementation to enhance a balance supply of nutrients in the basal diet.

Two main categories of feed supplements are high energy and high protein supplements. The former consists of oil seeds, tubers and grains of high nitrogen (N) free extract and degradable nutrient with low in protein, while protein supplements are feedstuffs containing more than 20% protein or protein equivalent. Protein supplement can either come from true protein or non-protein nitrogen sources. Protein feeds are generally expensive and their use as N supplement is determined by the need of animal and economics.

One alternative way to reduce cost of concentrate supplements is to make better use of legume forages, which can be grown easily in the tropics. The ability of protein supplements to enhance livestock productivity of many ruminant species in the tropics has been well reported (Robertson, 1988; Ahn, 1990; Reed *et al.*, 1990;

Muinga *et al.*, 1992). Besides, tropical leguminous shrubs have multiple uses such as for fuelwood, weed control, erosion control, land stabilisation and fencing material (Leng, 1995).

Recently, legume forages that exhibit desirable fodder characteristics are been given research priority in many tropical countries. These legumes are mainly from the genera, *Acacia*, *Albizia*, *Desmanthus*, *Desmodium*, *Gliricidia*, *Leucaena*, *Prosopis* and *Sesbania* (Brewbaker and Hutton, 1979; Brewbaker, 1986).

In Malaysia, *Gliricidia sepium* is highly productive, well adapted to acid soils and used as shade plant for cocoa and coffee plants (Wong and Anuar, 1999). Similarly, *Arachis pintoii* has adapted to a wide range of climate and soil conditions, even under heavy grazing (Stur and Ndikamana, 1993). Planting of *A. pintoii* has been encouraged because of its value as a forage and a shade tolerant ground cover in the humid areas (Cook *et al.*, 1993). In Malaysia it has been introduced and planted as ground cover in oil palm plantations and as an ornamental plants (Wong, 1996).

Leucaena leucocephala is the most widely used species as fodder shrub for increased animal production in the tropics. However, *Leucaena* is susceptible to psyllid attack. As a result, two new hybrids, *Leucaena hybrid-Bahru* (*Leucaena-Bahru*) and *Leucaena hybrid-Rendang* (*Leucaena-Rendang*) which have been shown to be well adapted to acid soil and psyllid resistance were recently released (Wong, 1998). Information on the nutritive value of the two new hybrids is lacking and thus there is a need for a systematic investigation on the forage quality aspects of utilisation.